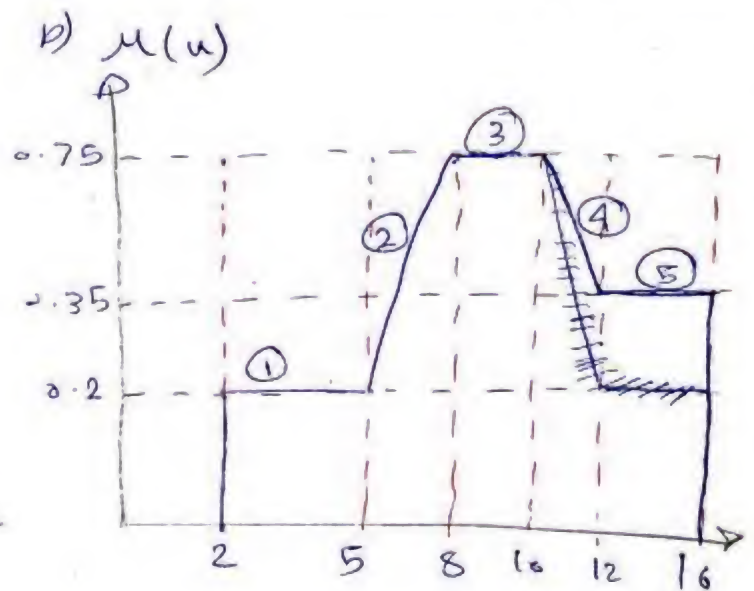
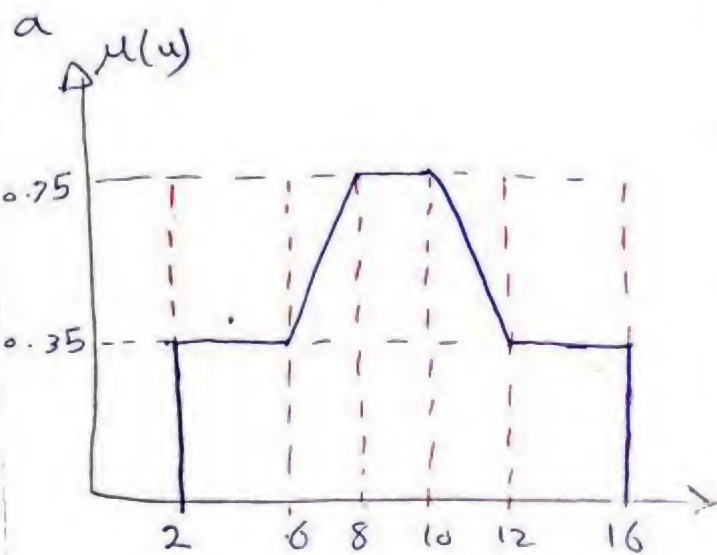


Sheet 4

Sec 5

1) Find the crisp out of the Fuzzy controller that has the following overall Fuzzy output ~~as~~ shown in following cases



overall Fuzzy o/p

دالة مركزية

CoG

$$u^{crisp} = \frac{\int \mu(u) u \, du}{\int \mu(u) \, du}$$

دالة

weighted average

دالة

$$u^{crisp} = \frac{\sum \mu(u_i) u_i}{\sum \mu(u_i)}$$

For a

$$\mu^{\text{crisp}} = \frac{0.75 \times 9}{0.75} = 9$$

For b

$$\mu^{\text{crisp}} = \frac{\int \mu(u) u \, du}{\int \mu(u) \, du} = \frac{I_1}{I_2}$$

$$\begin{aligned} I_1 = & \int_2^5 0.2 u \, du + \int_5^8 \left(\frac{0.55}{3} u - \frac{2.15}{3} \right) u \, du + \int_8^{10} 0.75 u \, du \\ & + \int_{10}^{12} (-0.2 u + 2.75) u \, du + \int_{12}^{16} 0.35 u \, du \end{aligned}$$

From 5 \rightarrow 8

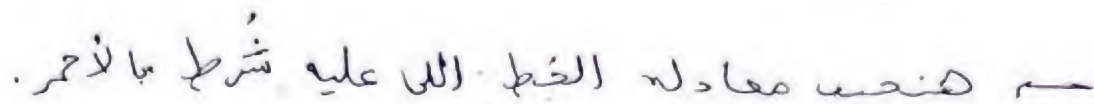
$$\frac{\mu(u) - 0.2}{u - 5} = \frac{0.75 - 0.2}{8 - 5} \Rightarrow \frac{0.55 u}{3} - \frac{2.15}{3} = \mu(u)$$

From 10 to 12

$$\frac{\mu(u) - 0.75}{u - 10} = \frac{-0.4}{2} \Rightarrow \mu(u) = -0.2 u + 2.75$$

(2)

$$u^{\text{crisp}} \leq \frac{I_1}{I_2} \leq 12.3$$



3

$$\mu(u) = 0.2u - 0.85$$

$$\text{Put } \mu(u) = 1 \rightarrow \text{to let } u$$

$$\therefore u = 9.25$$

From (9.25, 1) to (10, 0.75)

$$\frac{\mu(u) - 1}{u - 9.25} = \frac{-0.25}{0.75} = -\frac{1}{3}$$

$$\mu(u) = -\frac{1}{3}u + \frac{12.25}{3}$$

$$\text{Put } \mu(u) = 0.35 \Rightarrow u = 11.2$$

↳ not symmetric so we will use CoG.

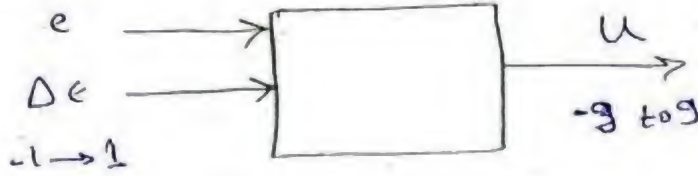
$$u^{\text{crisp}} = \frac{\int \mu(u) u du}{\int \mu(u) du} = \frac{I_1}{I_2}$$

$$I_1 = \int_2^6 0.35 u du + \int_5^8 (0.2u - 0.85) u du +$$

$$\int_{9.25}^{11.2} \left(-\frac{1}{3}u + \frac{12.25}{3}\right) u du + \int_{11.2}^{16} 0.35 u du = \checkmark$$

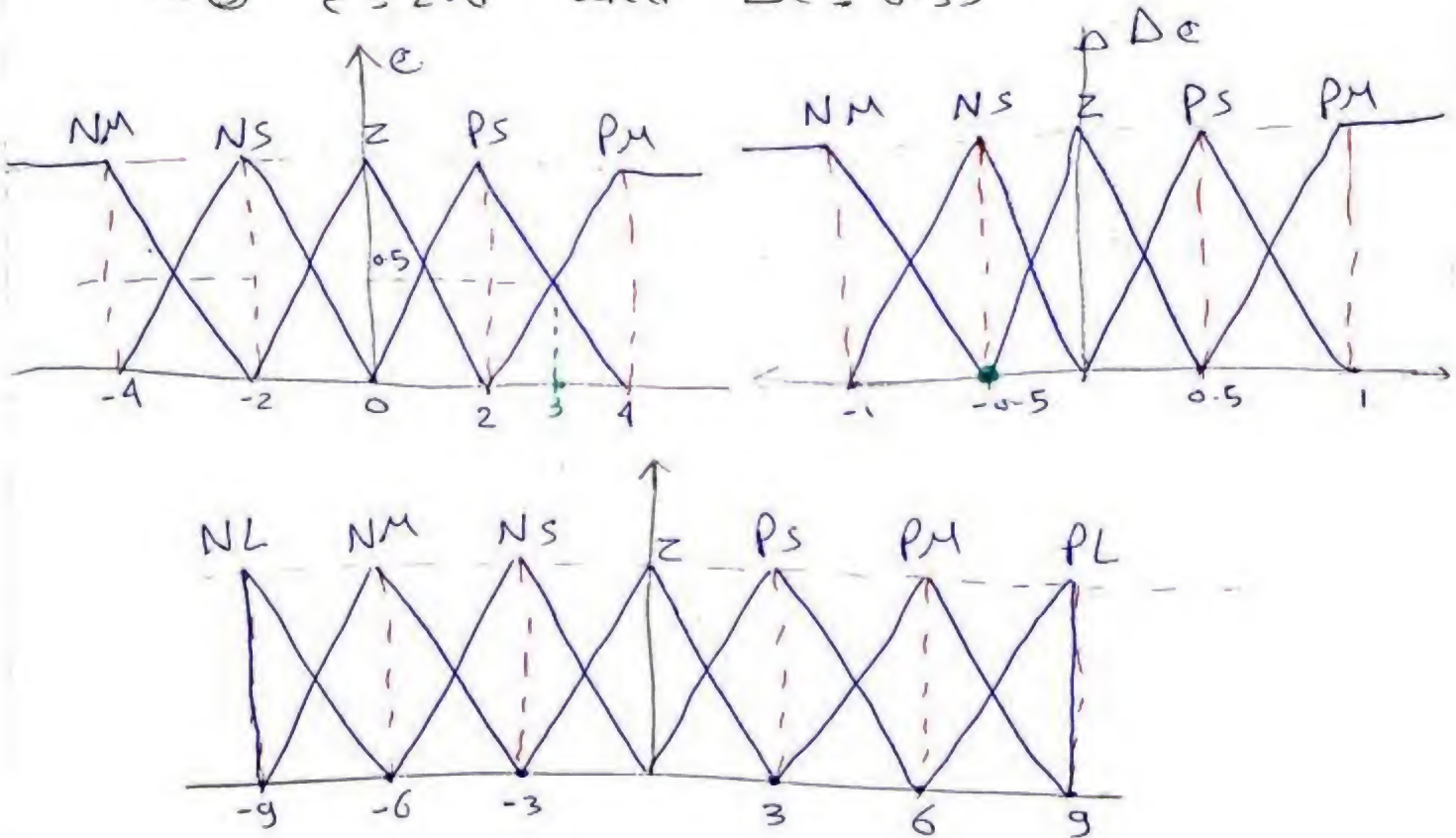
*

$-4 \rightarrow 4$



crisp
u

- ① $e = 3$ and $\Delta e = -0.5$
- ② $e = -2$ and $\Delta e = -0.2$
- ③ $e = 2.6$ and $\Delta e = 0.35$



Δe \ e	NM	NS	Z	PS	PM
NM	PL	PL	PM	PS	Z
NS	PL	PM	PS	Z	NS
Z	PM	PS	Z	NS	NM
PS	PS	Z	NS	NM	NL
PM	Z	NS	NM	NL	NL

← عكس المجموع الجبري
 $NM + NM = NL \Rightarrow PL$

$e = 3 \rightarrow \begin{cases} PS \text{ with } \mu_{PS}(e) = 0.5 \\ PM \text{ with } \mu_{PS}(e) = 0.5 \end{cases}$

$\Delta e = -0.5 \rightarrow NS \text{ with } \mu_{NS}(\Delta e) = 1$

Fired rules

R1: if e is PS & Δe is NS then u is Z

R2: if e is PM & Δe is NS then u is NS

→ The degree of Premise

$$R_1: \mu_{P_1} \wedge \min\{\mu_{PS}(e), \mu_{NS}(\Delta e)\}$$

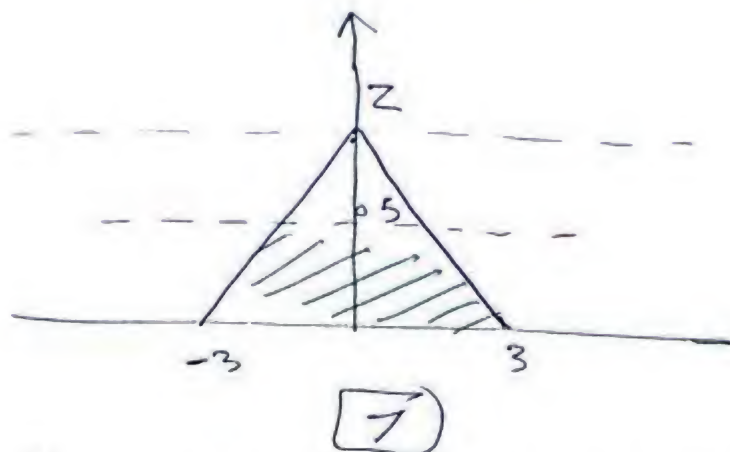
$$\wedge \min\{0.5, 1\} = 0.5$$

$$R_2: \mu_{P_2} \wedge \min\{\mu_{PM}(e), \mu_{NS}(\Delta e)\}$$

$$\wedge \min\{0.5, 1\} = 0.5$$

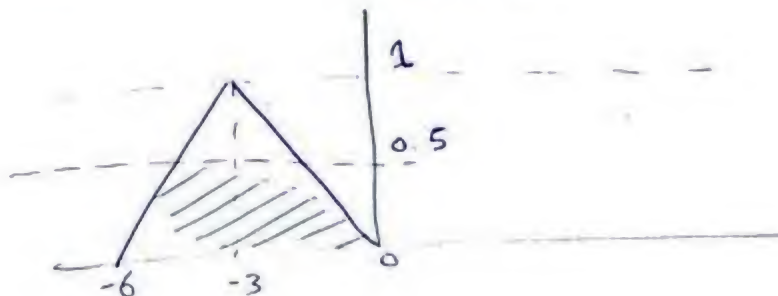
The Fuzzy forms of a/p

$$R_1 \Rightarrow \mu_Z(u) = \min\{\mu_{P_1}, \mu_Z(u)\} \wedge \min\{0.5, \mu_Z(u)\}$$

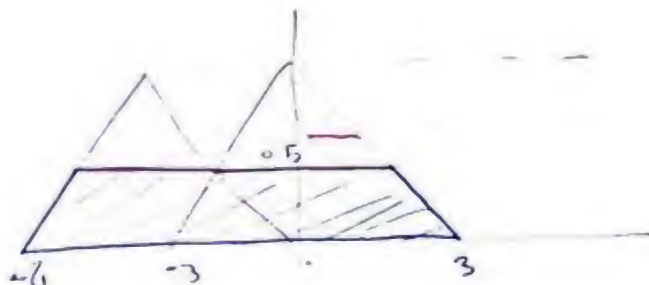
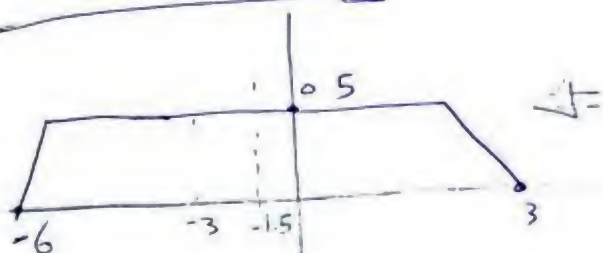


$$R_2 \rightarrow \mu_{NS}(u) \min \left\{ \mu_{P_2}, \mu_{NS}(u) \right\}$$

$\hookrightarrow 0.5$



Aggregation



overall fuzzy o/p

crisp
 $u = -1.5$

a)

$$e=2 \rightarrow NS$$

$$\text{at } \mu(e) = 1$$

$$\Delta e \rightarrow NS \quad \mu(\Delta e) = 0.4$$

$$\rightarrow Z \quad \mu(\Delta e) = 0.6$$

بما في الجدول في رقم ٨

8